Homework 2023

Perform the kinematics and kineto-statics analyses of the **four-bar mechanism** which is functioning in a vertical plane on Earth with following dimensions:

- crank length: $AB = 0.2$ [m] with $A \equiv O$ – origin of reference system;
- coupler link length: $BC = 0.8$ [m];
- rocker length: $CD = 0.6$ [m];
- fixed element length: $AD = 1$ [m], with $D \in OX$.

Output tracing point T of the four-bar mechanism is located on coupler link, but outside BC segment, at distance $CT = 0.5$ [m] from C (bar CT is fixed - welded - to coupler link bar BC, making the same rigid body), by making an angle $\psi = -\pi/3$ (i.e. measured clockwise) with respect to the direction from B to C, so that its relative polar co-ordinates with respect to point C are $T(CT, \psi)$.

In point T is actuating a force $\boldsymbol{F} = 100$ [N] on horizontal direction with respect to Earth in reverse direction with respect to positive sense of OX axis of right Cartesian reference system. Bars of mechanism are of constant transversal section with linear density of 10 [kg/m].

Requirements:

1) *Drawing* of the four-bar mechanism (to an A3 format at a specific chosen scale) in the positions of crank corresponding to angle with OX axis: $\varphi_2 = (i - 1)\, 2\pi/n$ [rad], where $i =$ ….. (position of student in group list) and $n =$ ….... (number of students from group), and also on same drawing the extreme positions of it. Measure and verify the extreme positions of rocker.

2) *Computations* for position of the crank corresponding to angles: $\varphi_2 =$ ..... [rad] and for angular speed of the crank of constant value $\omega_2 = 3$ [rad/s] of:
   a) number of degree of mobility of the four-bar mechanism and verification of the presence of the crank (Grashof theorem/conditions);
   b) for kinematics analysis:
      – positions, speeds and accelerations of caracteristic points of the four-bar mechanism i.e.: B, C and T;
      – positions, speeds and accelerations of mass centres of all mobile elements of the four-bar mechanism;
   c) for kineto-statics analysis:
      – reaction forces in grounded joints A and D;
      – reaction forces in intermediary joints B and C;

3) *Plots* the following graphs (by transfer information between all students from group):
   a) for kinematics analysis:
      – trajectory of tracing point T;
      – variation of speed and acceleration of tracing point T with respect to the position of the crank;
      – variation of the angular speed and acceleration coupler link and rocker link with respect to the position of the crank;
   b) for kineto-statics analysis (by transfer information between all students from group):
      – hodographs (plots in polar co-ordinates) of reaction forces in grounded joints A and D;
      – variation of the motor momentul $\boldsymbol{M_m}$ with respect to the position of the crank.

References: *Homework guides* and *cours* (Chapters 1, 2 and 3) in PDF format on Moodle.